Section 8.2 cont.  
Electrical Circuits

Battery – a source of electric energy  
+ pole (long line) / - pole (short line)  
Current flows out of + pole and into the - pole  
Measured in volts (V)

Resistor – an element that dissipates energy  
example: light bulb  
Measured in ohms (Ω)

Current – rate of flow of electrons in a wire  
Measured in amperes or amps (A)

Node – a point at which 3 or more wires are joined

Branch – wire connecting two nodes

Closed loop – a succession of connected branches that begin and end at the same node

The chosen direction in each loop is by convention chosen to be clockwise
**Ohm’s Law** – If a current of $I$ amperes passes through a resistor with a resistance of $R$ ohms, then there is a resulting drop of $E$ volts in electrical potential that is the product of the current and resistance. $E = IR$

**Kirchoff’s Current Law** – the sum of the currents flowing into any node is equal to the sum of the currents flowing out.

**Kirchoff’s Voltage Law** – in one traversal of any closed loop, the sum of the voltage rises is equal to the sum of the voltage drops.

A voltage **drop** (rise) occurs at a **resistor** if the direction assigned to the current through the resistor is the **same** (opposite) as the direction assigned to the loop.

A voltage **rise** (drop) occurs at a **battery** if the direction assigned to the loop is from **– to +** (+ to -) through the battery.
Choose any node:

\[ i_2 = i_1 + i_3 \]

Choose any loop:

\[ 3i_1 = 5i_3 + 10 \]
\[ 5i_3 + 6i_2 = 27 \]

**3 unknowns** means you need 3 equations

\[
\begin{align*}
-i_1 + i_2 - i_3 &= 0 \\
3i_1 - 5i_3 &= 10 \\
6i_2 + 5i_3 &= 27
\end{align*}
\]

\[
\begin{pmatrix}
-1 & 1 & -1 & | & 0 \\
3 & 0 & -5 & | & 10 \\
0 & 6 & 5 & | & 27
\end{pmatrix}
\]

\[
\begin{align*}
&-R_1 \\
&-3R_1 + R_2 \\
\downarrow &
\end{align*}
\]

\[
\begin{pmatrix}
1 & -1 & 1 & | & 0 \\
0 & 3 & -8 & | & 10 \\
0 & 6 & 5 & | & 27
\end{pmatrix}
\]

\[
\begin{align*}
&\frac{1}{2}R_2 \\
&-6R_2 + R_3 \\
\downarrow &
\end{align*}
\]

\[
\begin{pmatrix}
1 & -1 & 1 & | & 0 \\
0 & 1 & -8 & | & 10 \\
0 & 0 & 1 & | & \frac{1}{3}
\end{pmatrix}
\]

\[
\begin{align*}
i_1 &= i_2 - i_3 \Rightarrow i_1 = \frac{35}{9} \\
i_2 &= \frac{10}{3} + \frac{8}{3}i_3 \Rightarrow i_2 = \frac{38}{9} \\
i_3 &= \frac{1}{3}
\end{align*}
\]